STUDIES ON CAPTIVE BREEDING OF THE GHARIAL, *GAVIALIS GANGETICUS* (GMELIN) IN ORISSA[1]

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The gharial *Gavialis gangeticus* Gmelin bred in captivity for the first time at the Nandankanan Biological Park, Orissa in 1980. Since then, breeding of this species is a regular feature in the park. This paper embodies data on courtship, mating, egg-laying, nests, clutch size, incubation and hatching success recorded in the park during the fifteen year period from 1980 to 1994.

Introduction

The river Mahanadi and its tributaries in the State of Orissa are within the southern most limit of distribution of the gharial (*Gavialis gangeticus*), considered as an endangered species. Several attempts are being made in the country to save the species from extinction. Captive breeding is considered as one such attempt. The Government of Orissa (State Forest Department) has initiated a project on captive breeding of gharial at the Nandankanan Biological Park (the park lies within the geographical range of the species) with assistance from Government of India since 1975 - 76. The technical expertise for this project was provided by FAO / UNDP Consultant Dr. H.R. Bustard.

A large oval-shaped concrete breeding pool, with a capacity of 2.7 million litres was constructed inside the park. The pool measured 60 m at the longest part, 30 m at the widest part and had a depth of 9.15 m at its deepest. There was a 2.4 m sand bank with suitable riverine vegetation on one side of the enclosure for egg-laying and basking. The area was fenced with a 2 m high wall all around the area except 30 m on the viewers' side where a dry moat and a parapet 0.5 m high was provided.

The three near adult gharials, then available in the park, measuring 2.7 m (male), 2.5 and 2.65 m (females) were released into this breeding pool during February, 1976. Subsequently, four more sub-adult females measuring 2.3 m (one) and 1.5 to 1.8 m (three) were added in 1979 to this pool. In January, 1980, an adult male measuring 3.7 m received on breeding loan from the Frankfurt Zoological Society, Germany was added, increasing the breeding population to eight (2:6). Unfortunately, the resident male was killed by the Frankfurt male during the breeding season in February, 1980.

The first successful breeding of the Gharial was recorded in 1980 and since then, the species is breeding regularly. This paper records the observations made on aspects of breeding of the Gharial in the Nandankanan Biological Park, Orissa during the last fifteen years from 1980 to 1994.

Observations and Discussion

Courtship, mating and egg-laying: Courtship and mating of the gharials have been observed during the winter months (January and February) every year. All the 57 clutches of eggs laid by six female gharials during a period of 15 years (1980-1994) was recorded regularly during the month of March (8-30) only. According to Table 1 the first female laid only five clutches during eight years from 1980 to 1987 and no further egg-laying was recorded for this female from 1988 to 1994 (seven years). The second

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TABLE 1

YEAR OF EGG-LAYING : CLUTCH SIZE

Sl. No.	Particulars of Female Gharials	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total Number of eggs Laid (Total Number of Clutches)	Mean Clutch Size (Range of Clutch Size)
1.	First	25*	Nil	27	15	27	Nil	Nil	28	Nil	Nil	Nil	Nil	Nil	Nil	Nil	122 (5)	24.40 (15-28)
2.	Second	Nil	5*	28	14	28	29	31	26	32	32	36	38	39	Nil	Nil	338 (12)	28.17 (5-39)
3.	Third	Nil	Nil	Nil	5*	Nil	12	25	15	5	35	Nil	36	42	Nil	21	196 (9)	21.78 (5-42)
4.	Fourth	Nil	Nil	Nil	Nil	33*	32	32	37	42	34	39	39	31	51	26	396 (11)	36.00 (26-51)
5.	Fifth	Nil	Nil	Nil	Nil	29*	35	36	Nil	37	32	42	42	51	47	57	408 (10)	40.80 (29-57)
6.	Sixth	Nil	Nil	Nil	Nil	Nil	30*	33	34	2	46	38	50	44	47	48	372 (10)	37.20 (2-50)
	Total Number of Eggs (Number of Clutches)	25 (1)	5 (1)	55 (2)	34 (3)	117 (4)	138 (5)	157 (5)	140 (5)	118 (5)	179 (5)	155 (4)	205 (5)	207 (5)	145 (3)	152 (4)	1832 (57)	32.14 (2-57)

* Indicate first egg laying.

female laid 12 clutches of eggs from 1981 to 1992 continuously but egg-laying was not recorded during the subsequent two years (1993 and 1994). The third female laid nine clutches of eggs from 1983 to 1994 with no record of egg-laying during 1984, 1990 and 1993. The fourth female laid 11 clutches in 11 years from 1984 to 1994. The fifth female laid 10 clutches of eggs from 1984 to 1994 with no egg-laying during 1987. The sixth female laid 10 clutches of eggs continuously from 1985 to 1994. These observations suggest that annual egg-laying is not a regular feature in all the individual female gharials. It was not possible to ascertain the reasons of failure of the first female to lay eggs continuously for seven years since 1988. In no year, more than five female Gharials laid eggs. It is presumed that one male might not be able to mate with more than five females during each breeding season.

According to Whitaker and Basu (1982) mating of gharial takes place between December - January (the winter months) with low water levels and low temperatures. Mating occurs in water in cold weather months of December - January (Daniel 1983). He further states that the gharials nest in late March, early April and the nesting season does not vary by more than 10 days in any year and the females in an area nest more or less within a week. All the nine nests of 1976, located in the Narayani and Kali-Gandaki Rivers in Nepal were laid between 29th March to 21st April (Bustard 1980). No information on the frequency of egg-laying of individual gharials could be found in the available literature.

Nest: Observations on 28 nests of five egg-laying females were made between 1986 to 1991. The distance of the nest on the sand bank from the water's edge of the breeding pool varied from 5.71 m to 10.94 m (mean 8.02 m). The nests were pitcher shaped, diameter varying from 38 to 120 cm (mean 56.6 cm, n = 21 nests). The upper depth of the nest varied from 20 to 45 cm (mean 28.4 cm) and the lower depth of the nests varied from 33 to 70 cm (mean 45.04 cm). The eggs were laid in layers.

One of the nests in the Satkosia Gorge Sanctuary, Orissa was at a distance of 5.9 m from the water's edge at a height of 2.6 m above the water level (Singh and Bustard 1977). Whitaker and Basu (1982) stated that gharials dig their pitcher-shaped nest holes on steep sandy river banks at night and the average nest hole is 40 cm deep. The first layer of eggs in one clutch laid in Satkosia Gorge Sanctuary was 37.5 cm below the surface and the bottom 30 x 22.5 cm (Singh and Bustard 1977). The study of 28 nests in Chambal river revealed that nests were located at a distance of 4.6 to 14.5 m (mean 9.5 m) and at a height of 1.5 to 3.5 m (mean 2.4 m) from water (Whitaker and Basu 1982). They stated that three nests along Girwa river were situated 2.5 to 4.0 m (mean 3.2 m) and at a height of 1.0 to 3.0 m (mean 2.0 m). Nest depth varied from 30 to 37 cm with a width of 22 cm (Daniel 1983).

Clutch size: Table 1 shows that six female gharials laid 1832 eggs in 57 clutches from 1980 to 1994. The clutch size varied from 2 to 57 (mean 32.14). The clutch size of first female varied from 15 to 28 (mean 24.40); second female 5-39 eggs (mean 28.17); third female 5-42 eggs (mean 21.78); fourth female 26-51 eggs (mean 36.00); fifth female 29-57 eggs (mean 40.80) and sixth female 2-50 eggs (mean 37.20). Each female gharial laid a single clutch during each breeding season. There is great variation in clutch size of individual female gharials. More observations on the breeding biology of captive gharials are required to understand such variation.

The clutch size of eggs recorded in Narayani and Kali-Gandaki Rivers in Nepal in 1976 (nine nests) varied from 16 to 39 eggs (mean 25.5); in 1977 (16 nests) the range was 16 to 61 (mean 36.9) eggs and in 1978 (10 nests) the range was 18 to 45 (mean 31.0) eggs (Bustard 1980). The clutch size varies from 10 to 96 with an average of 40 eggs (Daniel 1983). The study of clutch size of gharial eggs of Girwa / Chambal Rivers in India and Rapti / Narayani Rivers in Nepal during 1976 to 1980 reveals that 3147 eggs were laid in 80 clutches with a mean of 39.30 eggs (range 18-95) (Whitaker and Basu 1982). According to Smith (1931), gharials lay about 40 or more eggs in sand banks.

Incubation and Hatching: The incubation period observed in 47 cases (date of egg laying to

the date of hatching, both days inclusive) in nest varied from 55 to 79 days with a mean of 65.1 days. Similarly the incubation period observed in 44 cases in artificial hatchery varied from 57 to 89 days, with a mean of 71 days. This variation of incubation period recorded in different years may be due to the influence of local climatic factors. It is interesting to note that the incubation period observed in artificial hatchery was invariably longer than in natural nests. This might be due to the fluctuations in temperature during the process of translocation of eggs from natural nests to artificial hatchery.

Incubation period ranged from 72 to 92 days with a mean 84.5 days (Daniel 1983). According to Bustard (1980) the mean incubation period observed during 1976 and 1978 in Narayani and Kali-Gandaki Rivers in Nepal was 84 and 83 days, respectively, whereas the mean incubation period observed among 16 nests during 1977 in the same area was 94 days and this was attributed to low temperature existing in the natural sand bank in that year as a result of early April pre-monsoon shower at the time of egg laying, which persisted till the onset of the monsoons in June. Singh and Bustard (1977) stated that Gharial eggs incubated at Tikerpada in April-June, 1975 under artificial hatchery conditions, hatched after 71-76 days. Gharial nests on the Chambal took an average of 60 to 65 days to hatch (Whitaker and Basu 1982). Young gharials appear in March and April (Smith 1931).

Of 1832 eggs, 1046 eggs were allowed to incubate in natural nest and the rest 786 were shifted to an artificial hatchery about 50 m away for incubation. The eggs were shifted to the hatchery invariably during the second half of incubation period, i.e. from late April to early May.

In all, 576 hatchlings hatched during May and June (7 May to 11 June) out of 1046 eggs kept in the natural nest (55.07% hatching success), whereas 659 eggs have hatched (7 May to 15 June) out of 786 eggs kept in the artificial hatchery (83.84% hatching success). Thus, 1235 hatchlings hatched, out of total 1832 eggs laid (67.41% hatching success). The percentage of hatching was higher in hatchery in comparison to natural nest, which may be due to controlled temperature and moisture conditions in the hatchery.

The weight and measurements recorded in 49 newly hatched gharial hatchlings during the year 1986, 1990 and 1991 revealed that the hatchlings measured from 35 to 40 cm with mean of 37.35 cm including tail lengths of 18 to 21 cm (mean 19.6 cm). The weight ranged from 100 to 124 gm with a mean of 116.34 gm. According to Smith (1931) the newly hatched gharial hatchlings measure 375 mm. Hatchlings measured on an average 325-375 mm at birth with a weight range of 75-97 gm (Daniel 1983).

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